SLINKARD G-E-M

RESOURCES AREA

(GRA NO. CA-01)

TECHNICAL REPORT

(WSAs CA 010-105 and NV 030-531)

Contract YA-553-RFP2-1054

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Final Report

April 22, 1983

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EXECUTIVE SUMMARY

The Slinkard Geology-Energy-Minerals (GEM) Resource Area (GRA) is on the east edge of the Sierra Nevada in Mono and Alpine Counties, California. It is five miles east of Topaz Lake and of the nearby communities along the California-Nevada boundary. There are two contiguous Wilderness Study Areas (WSAs) in the GRA: CA 010-105 which is administered by the Bakersfield District Office in California, and NV 030-531 which is administered by the Carson City District office in Nevada although the WSA is in California.

Throughout most of the GRA, Tertiary volcanic rocks perhaps as much as 20 million years old are exposed and most of the known mineralization in and near the GRA is related to the volcanism that produced these rocks. The volcanic rocks are underlain by much older metamorphosed sediments and volcanic rocks, and granitic bodies intruded into them, that are 200 million years old or more. These rocks are exposed in a small part of WSA CA 010-105. Where these rocks are exposed elsewhere in the region they contain some ore deposits formed during an old period of mineralization; such deposits, if they are present in the GRA, are covered by the younger volcanic rocks.

There are two mining districts in the GRA: Monitor-Mogul about five miles northwest of the WSAs with perhaps $3 million production in gold and silver, and Silver Mountain about 10 miles west of the WSAs with an estimated $300,000 production of gold and silver. Much of the western half of the GRA is apparently completely covered with unpatented mining claims, probably located on the very extensive altered zones described in connection with the mining districts.

In the eastern half of the district, where the WSAs lie, there are no patented claims and few unpatented claims. However, of those few unpatented claims, the majority lie along the boundary between WSA CA 010-105, and NV 030-531, and thus are within one or the other WSA. There are no oil and gas, sodium and potassium, or geothermal leases in the GRA. On the west edge of the GRA is Wolf Creek rock quarry, in the Stanislaus National Forest. No material sites are known in or near the WSAs.

The northeastern one-fourth of WSA CA 010-105 is classified as having very low favorability with moderate confidence for metals, because it is exposed granite with nothing to indicate favorability for metallic minerals. Part of the western edge of the WSA is classified as having low favorability with very low confidence for metals in the surficial volcanics, because of the presence of mining claims and an inferred deep-seated fault that may have introduced mineralizing solutions. All of the WSA except the northeastern one-fourth is classified as having low favorability with very low confidence for potential porphyry copper resources in the older rocks that lie beneath the cover of younger volcanic rocks. The entire WSA has moderate favorability

with low confidence for uranium, because of the favorability of the Tertiary extrusive rocks as souces for uranium and as host rocks as well, and the favorability of the granitic rocks as source rocks. The WSA has low favorability with low confidence for thorium deposits in the granitic rocks. The entire WSA has low favorability with low confidence for nonmetallic minerals. There is very low favorability with high confidence for oil and gas and for sodium and potassium. The entire WSA has moderate favorability with low confidence for geothermal resources on the basis of the young volcanics that can provide a heat source, numerous faults to provide passageways for geothermal fluids, and the presence of hot springs a few miles north of the WSA along the structural trend.

The northeastern part of WSA NV 030-531 has low favorability with very low confidence for metallic minerals on the basis of mining claims and a deep-seated fault. All of the WSA has low favorability with very low confidence for potential porphyry copper resources in the older rocks below the volcanics. The entire WSA has moderate favorability for uranium with low confidence and low favorability for thorium with low confidence, for the reasons given above under WSA CA 010-105. It has low favorability for nonmetallic minerals, with very low confidence. It has very low favorability for oil and gas and for sodium and potassium, with a high level of confidence. It has moderate favorability for geothermal resources, with a low level of confidence, for the reasons given above.

Field work is recommended to determine the reason for mining claims in the WSAs, and to map and sample mineralization if it is present.

I. INTRODUCTION

The Slinkard G-E-M Resources Area (GRA No. CA-01) contains approximately 160,000 acres (646 sq km) and includes the following Wilderness Study Areas (WSAs):

WSA Name	WSA Number
Slinkard	CA 010-105
Dump Canyon	NV 030-531

The GRA is located in California within the Bureau of Land Management's (BLM) Folsom Resource Area, Bakersfield district, and WSA CA 010-105 is administered by that office, the adjacent WSA NV 030-531 is administered by the Carson City Office in Nevada although it lies within California. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 38°40' north latitude, 119°40' west longitude and includes the following townships:

T 10 N, R 21,22 E	T 8 N, R 21-23 E
T 9 N, R 21,22 E	

The areas of the WSAs are on the following U. S. Geological Survey topographic maps:

15-minute:

Topaz Lake (CA-NV)

The nearest town is Markleeville which is located about 28 miles northwest of the GRA on State Highway 89. Access to the area is via Highway 89 between State Highway 4 to the west and U. S. Highway 395 to the east. Access within the area is via Loope Canyon, Leviathan Creek, Bagley Valley and Slinkard Valley and other unimproved roads and jeep trails.

Figure 2 outlines the boundaries of the GRA and the WSAs on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin and Range Province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

None of the WSAs in this GRA were field checked.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included with the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

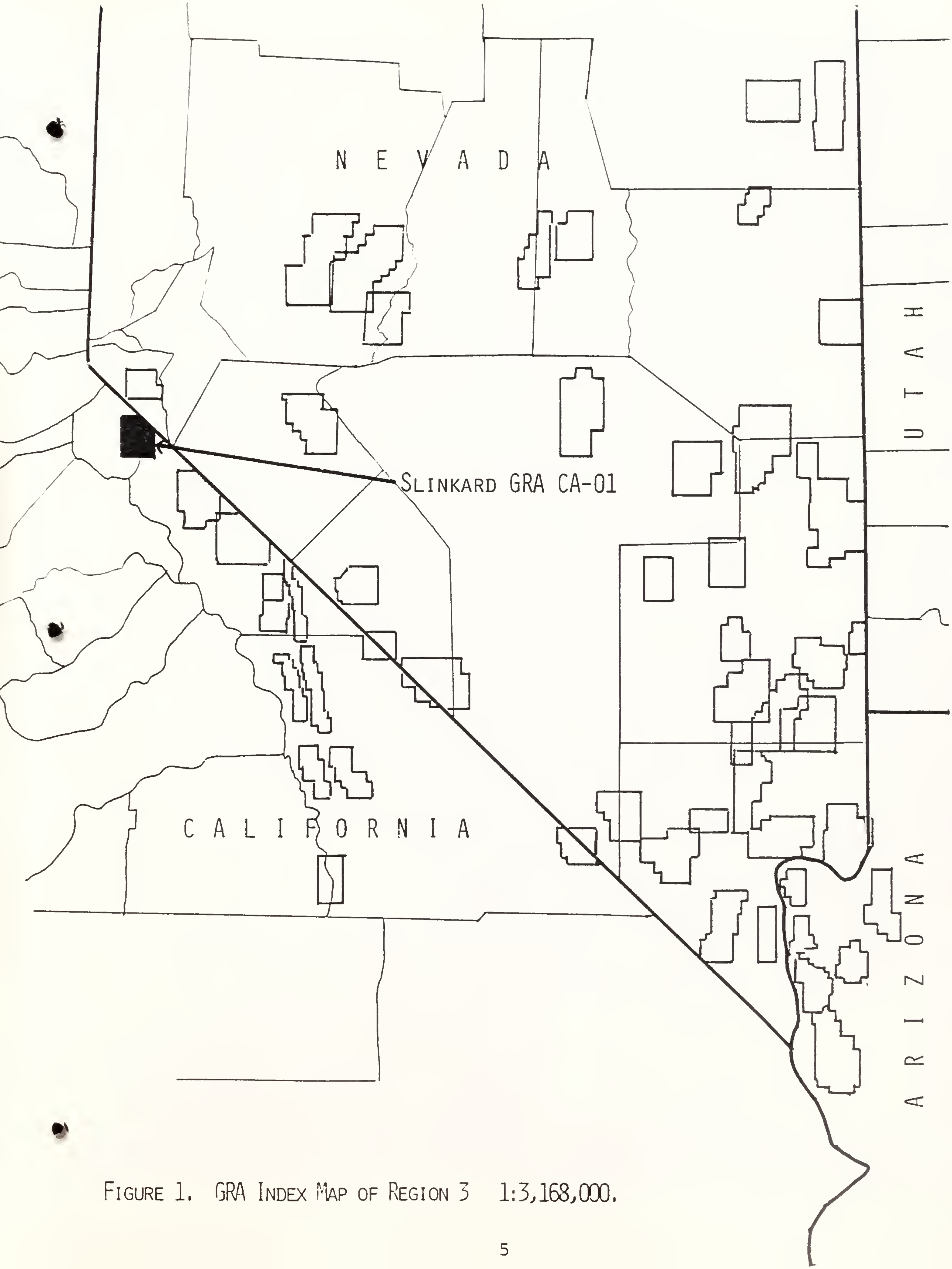
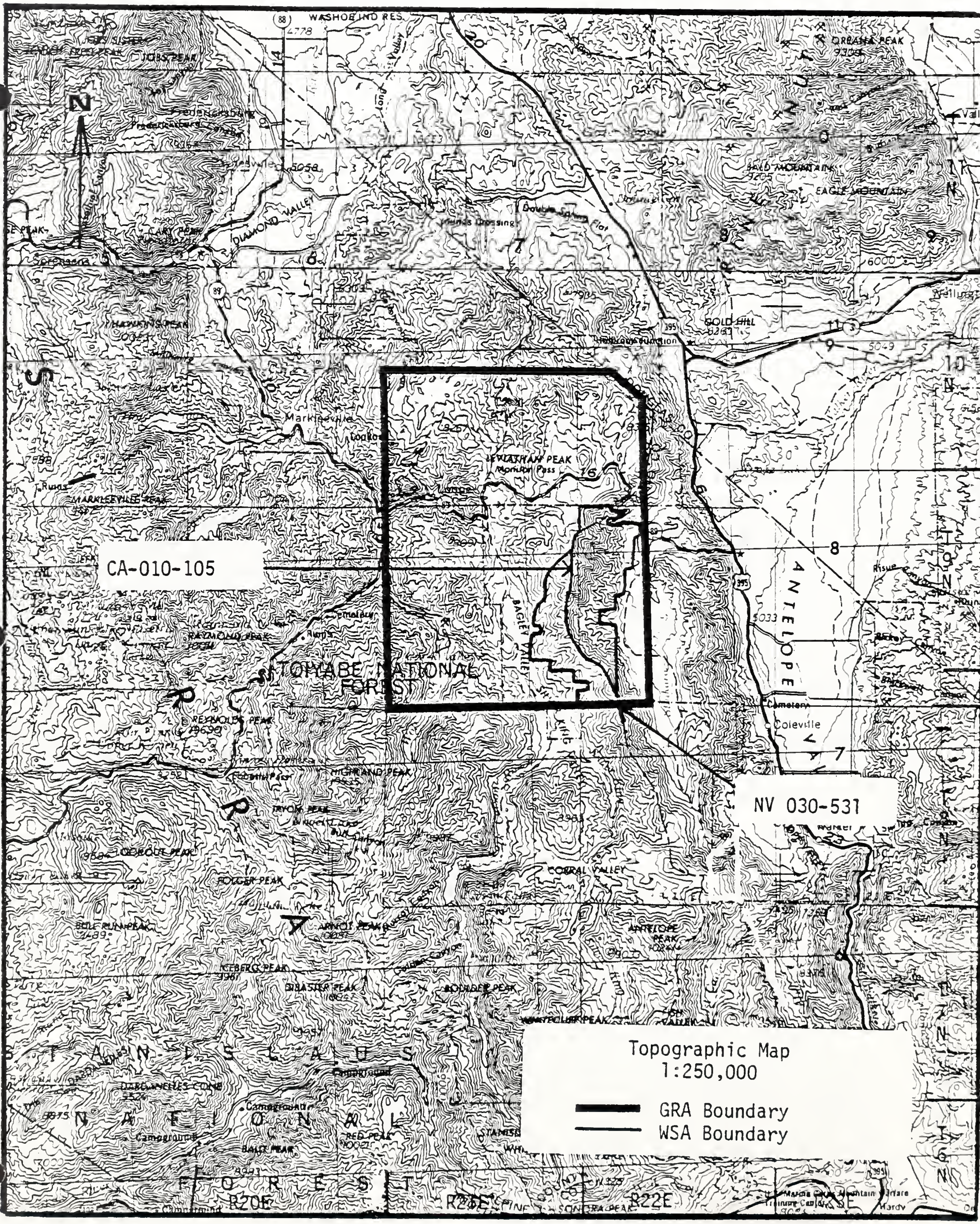


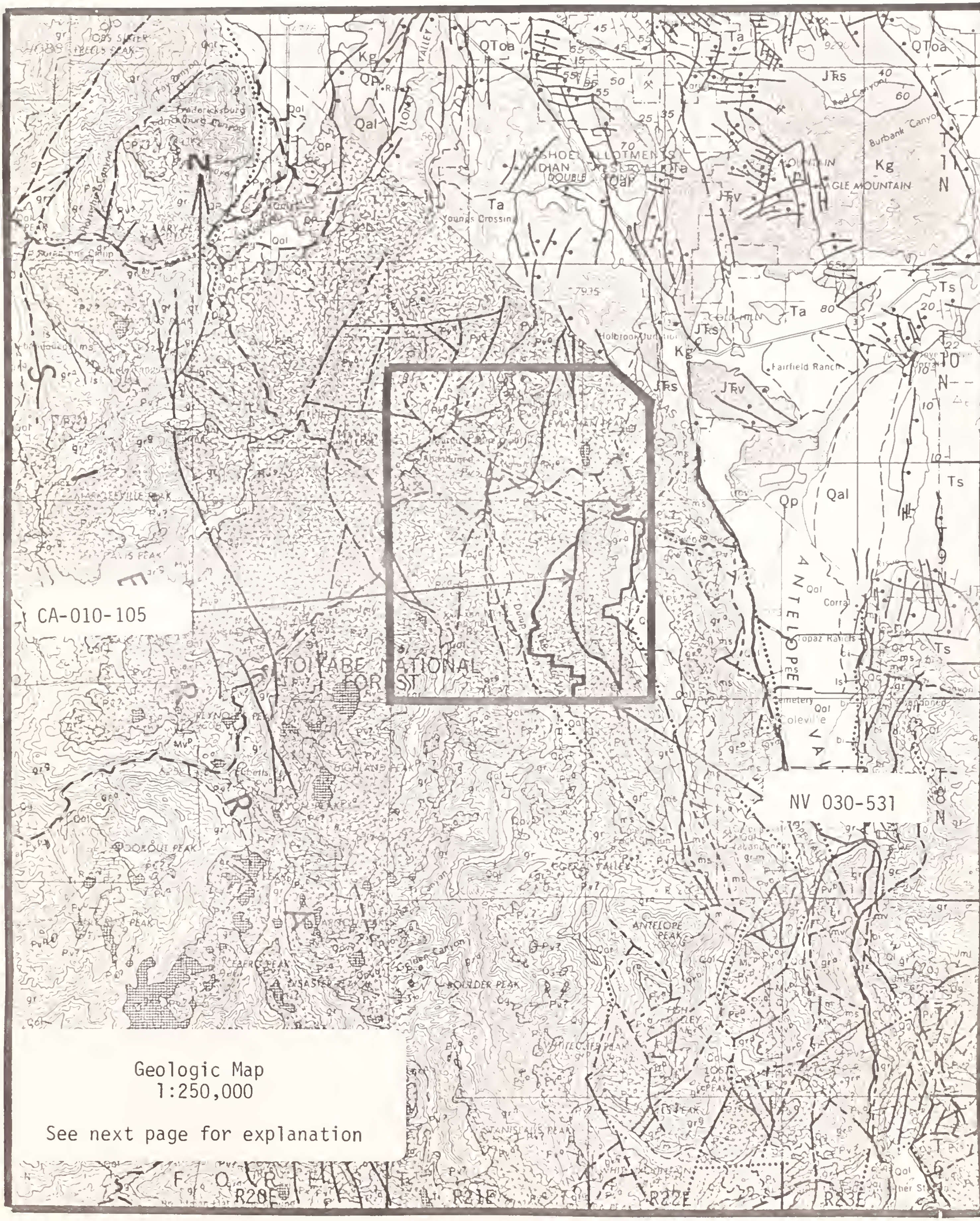
FIGURE 1. GRA INDEX MAP OF REGION 3 1:3,168,000.



Walker Lake Sheet

Slinkard GRA CA-01

Figure 2



Walker Lake Shet, Koenig (1963); Douglas County Geologic Map, Moore (1969)

Slinkard GRA CA-01

Figure 3

EXPLANATION

SEDIMENTARY AND METASEDIMENTARY ROCKS

CENOZOIC

QUATERNARY

Recent

- Qs — Dune sand
- Qal — Alluvium
- GREAT VALLEY:
  - Qsc — Stream channel deposits
  - Qf — Fan deposits
  - Qb — Basin deposits
- Qst — Salt deposits
- Ql — Quaternary lake deposits
- Qg — Glacial deposits
- Qt — Quaternary nonmarine terrace deposits

Pleistocene

- Qm — Pleistocene marine and marine terrace deposits
- Qc — Pleistocene nonmarine
- QP — Plio-Pleistocene nonmarine

TERTIARY

Pliocene

- Pc — Undivided Pliocene nonmarine
- Puc — Upper Pliocene nonmarine
- Pu — Upper Pliocene marine
- Pmlc — Middle and/or lower Pliocene nonmarine
- Pml — Middle and/or lower Pliocene marine

Miocene

- Mc — Undivided Miocene nonmarine
- Muc — Upper Miocene nonmarine
- Mu — Upper Miocene marine
- Mmc — Middle Miocene nonmarine
- Mm — Middle Miocene marine
- Ml — Lower Miocene marine

Oligocene

- Φc — Oligocene nonmarine
- Φ — Oligocene marine

Eocene

- Ec — Eocene nonmarine
- E — Eocene marine

Paleocene

- Epc — Paleocene nonmarine
- Ep — Paleocene marine

IGNEOUS AND META-IGNEOUS ROCKS

- Qrv — Recent volcanic: Qrv^r —rhyolite; Qrv^a —andesite; Qrv^b —basalt; Qrv^p —pyroclastic rocks
- Qpv — Pleistocene volcanic: Qpv^r —rhyolite; Qpv^a—andesite; Qpv^b —basalt; Qpv^p —pyroclastic rocks
- Quaternary and/or Pliocene cinder cones
- Pv — Pliocene volcanic: Pv^r –rhyolite; Pv^a—andesite; Pv^b —basalt; Pv^p —pyroclastic rocks
- Mv — Miocene volcanic: Mv^r —rhyolite; Mv^a —andesite; Mv^b —basalt; Mv^p —pyroclastic rocks
- Φv — Oligocene volcanic: $Φv^r$—rhyolite: $Φv^a$ —andesite; $Φv^b$—basalt; $Φv^p$—pyroclastic rocks
- Ev — Eocene volcanic: Ev^r —rhyolite; Ev^a —andesite; Ev^b —basalt; Ev^p —pyroclastic rocks

EXPLANATION CONT.

Paleocene

Ep	Paleocene marine

Undivided (Cenozoic)

QT	Cenozoic nonmarine	QT	Cenozoic volcanic: QTv' —rhyolite; QTva —andesite; QTvb —basalt; QTvp —pyroclastic rocks
Tc	Tertiary nonmarine	Tg	Tertiary granitic rocks
Tl	Tertiary lake deposits	Ti	Tertiary intrusive (hypabyssal) rocks: Ti' – rhyolite; Tia –andesite; Tib –basalt
Tm	Tertiary marine	Tv	Tertiary volcanic: Tv' —rhyolite; Tva —andesite; Tvb —basalt; Tvp —pyroclastic rocks

MESOZOIC

CRETACEOUS	K	Undivided Cretaceous marine		
CRETACEOUS	Ku	Upper Cretaceous marine	KJfv	Franciscan volcanic and metavolcanic rocks
CRETACEOUS	Kl	Lower Cretaceous marine	gr	Mesozoic granitic rocks: gra-granite and adamellite; grg-granodiorite; grt-tonalite and diorite
JURASSIC	Jk	Knoxville Formation	bi	Mesozoic basic intrusive rocks
JURASSIC	Ju	Upper Jurassic marine	ub	Mesozoic ultrabasic intrusive rocks
JURASSIC	Jml	Middle and/or Lower Jurassic marine	JRv	Jura-Trias metavolcanic rocks
TRIASSIC	R	Triassic marine		

KJf — Franciscan Formation

UNDIVIDED

m, ls	Pre-Cretaceous metamorphic rocks (ls = limestone or dolomite)	mv	Pre-Cretaceous metavolcanic rocks
ms	Pre-Cretaceous metasedimentary rocks	gr-m	Pre-Cenozoic granitic and metamorphic rocks
P, ls	Paleozoic marine (ls = limestone or dolomite	Pv	Paleozoic metavolcanic rocks

PALEOZOIC

PERMIAN	P	Permian marine	Pv	Permian metavolcanic rocks
CARBONIFEROUS	C	Undivided Carboniferous marine	Cv	Carboniferous metavolcanic rocks
CARBONIFEROUS	CP	Pennsylvanian marine		
CARBONIFEROUS	CM	Mississippian marine		
DEVONIAN	D	Devonian marine	Dv	Devonian metavolcanic rocks
			Dv?	Devonian and pre-Devonian? metavolcanic rocks
SILURIAN	S	Silurian marine		
	pSs	Pre-Silurian metasedimentary rocks	pS	Pre-Silurian metamorphic rocks
			pSv	Pre-Silurian metavolcanic rocks
ORDOVICIAN	O	Ordovician marine		
CAMBRIAN	Є	Cambrian marine		
	Є?	Cambrian – Precambrian marine	pЄc	Precambrian igneous and metamorphic rock complex

PRECAMBRIAN

pЄ	Undivided Precambrian metamorphic rocks pЄg = gneiss, pЄs = schist	pЄg	Undivided Precambrian granitic rocks
lpЄ	Later Precambrian sedimentary and metamorphic rocks	pЄan	Precambrian anorthosite
epЄ	Earlier Precambrian metamorphic rocks		

II. GEOLOGY

The Slinkard GRA is in east-central California in Mono and Alpine Counties approximately 10 miles southeast of Markleeville. WSA CA 010-105 lies entirely in Mono County, with its west boundary following the Mono-Alpine County boundary. WSA NV 030-531 lies entirely within Alpine County, contiguous with CA 010-105, with its eastern boundary following the Alpine-Mono County boundary. State Highway 89 runs east-west across the northern part of the GRA.

The GRA lies east of the crest of the Sierra Nevadas, in the moderately high and steep mountains that make up the foothills in this area. It is within the Sierra Nevada structural block. The WSAs occupy the eastern slope of a north-trending ridge, the peaks of which reach altitudes of nearly 9,000 feet.

The oldest rocks in the area are Paleozoic metasediments that are exposed fairly extensively immediately east of the GRA, but are not exposed within it. The metasediments have been intruded by Jurassic granitic bodies that are part of the Sierra Nevada batholith. Overlying these older rocks and covering them completely in most of the GRA, except in places along the eastern and southern boundaries, are Tertiary volcanic rocks.

1. PHYSIOGRAPHY

The GRA covers part of the eastern foothills of the Sierra Nevadas east of the crest of the range. Although these are foothills, numerous peaks reach elevations of nearly 9,000 feet, and valley floors are mostly somewhat above 6,000 feet. Slopes are steep but locally, particularly in the northern part of the GRA, there are broad rolling uplands at elevations of about 8,000 feet.

All drainages in the area ultimately discharge east of the Sierra Nevadas through either the Carson or the Walker rivers, but within the GRA most streams flow northward or southward. Slinkard Creek, which flows northward through Slinkard Valley immediately east of WSA CA 010-105, quickly turns east to join the West Walker River. Bagley Creek which drains the west side of the ridge, much of which is in WSA NV 030-531, flows southward to join the north-flowing East Carson River.

The GRA is in the Sierra Nevada province, but only a short distance east of it is the Basin and Range province.

2. ROCK TYPES

Almost all of the GRA is covered by Tertiary volcanics, with only small areas of older rocks at the eastern and southern borders, including some within WSA CA 010-105.

The only older rocks exposed in the GRA are granitic intrusives, but just east of the GRA are quite extensive exposures of metasedimentary and metavolcanic rocks (Koenig, 1963) that just across the border in Nevada are identified as being Triassic/Jurassic (Moore, 1969). Interspersed with these are exposures of granitic intrusives. Judging by the rather limited exposures in the roughly 1,000 square miles around the GRA, the western edge of the zone of metasediments and metavolcanics lies just east of the GRA, trending north-northwest. West of the zone, and including the GRA, is the main body of the Sierra Nevada batholith of late Jurassic age, in which there are few or no exposed remaining roof pendants of the metasediments and metavolcanics (Koenig, 1963 and Moore, 1969). Granitic intrusives, but none of the older intruded rocks, are exposed in and adjacent to the eastern edge of WSA CA 010-105. The implied lack of roof pendants, which are the favored sites for tungsten resources related to the Sierra Nevada intrusives, suggests that there is little reason to expect tungsten bodies where the older rocks are covered by Tertiary volcanics, though there is potential for Yerington-type porphyry copper deposits.

The predominant rock types in the GRA are andesite and rhyolite extrusive rocks, a thick sequence of which was extruded during the late Tertiary and early Quaternary. Andesite breccias, mudflows and tuffs and interbedded sediments were deposited over the granitic bedrock during the Miocene. The breccias contain large, angular fragments of porphyritic andesite. Pliocene extrusives include andesite and dacite flows and breccias, rhyolite and dacite flows and tuffs, and olivine basalt flows containing minor inclusions. A detailed description of the intrusives and particularly the volcanic rocks may be found in Curtis (1951).

The youngest rock unit is Quaternary alluvial material in Slinkard, Bagley and Silver King Valleys.

3. STRUCTURAL GEOLOGY AND TECTONICS

No pre-Tertiary structures have been recognized in the GRA, as might be expected in view of the limited exposures of the pre-Tertiary rocks. Even where there are greater exposures of the pre-Tertiary rocks farther east, however, recognition of pre-Tertiary structures is limited to generalizations (Curtis, 1951; Moore, 1969).

The Miocene and younger volcanic rocks were extruded from numerous vents in the eastern Sierra Nevada, and Curtis (1951) speculates that the vents were guided by north-south trending faults in the granitic rocks. Presumably these faults originated somewhat earlier in the Tertiary. Luedke and Smith (1981) identify only four volcanic vents -- all volcanic necks -- in the GRA. One of these is immediately south of the WSAs and two are immediately north of the WSAs. If Curtis is

correct in his speculation, this distribution suggests that there is a major and deep-seated fault below or very close to the WSAs, which may have implications for both geothermal and epithermal metal resources.

North-south faulting was active after most of the volcanic rocks were deposited. Tilting toward the west accompanied much of this faulting, with the result that in many places the volcanic rocks have a general westward dip. The exposure of granite in the eastern part of WSA CA 010-105 is one result of this tilting. Erosion on the scarp of the fault along the west side of Slinkard Valley was sufficient to remove the entire thickness of volcanic rocks and thus expose the underlying older intrusive body.

Many of the recognized faults in the GRA and nearby trend north-northwest or north, (Curtis, 1951; Clark, 1977), which suggests that they are Basin and Range type faults even though this area is within the Sierra Nevada province. It seems likely, from the faulting and the geomorphology (north-south ridges and valleys) that this is an overlap area of the Sierra Nevada and the Basin and Range provinces.

Other faults trend west-northwest or northeast. The age relations between these two trends, and between them and the north-northeast trend, are not known. Most of the fault activity took place prior to the Pleistocene (Curtis, 1951) but there may have been relatively minor displacement more recently on at least some of the faults.

4. PALEONTOLOGY

The Slinkard GRA lies in an area containing mostly Pliocene volcanic rocks, with subordinate metasediments. Potential for paleontological resources is minimal. The only lithology at all favorable is Quaternary alluvium, and the igenous and metamorphic provenance for that unit precludes the presence of reworked fossils. Lithologies contained within this GRA are pre-Cretaceous metasedimentary rocks, Pliocene volcanics, Mesozoic granitic rocks, and Quaternary alluvium.

5. HISTORICAL GEOLOGY

The late Triassic and early Jurassic metasediments and metavolcanics are the oldest products of geological activity in the area. Sediments and volcanic rocks are interbedded (map designations as to one or the other indicate only which type predominates in a given area), and some aspects of the association indicate that while the sediments were deposited in a marine environment, some of the volcanic rocks were formed in a terrestial or near-shore environment (Moore, 1969).

During the late Jurassic the numerous individual plutons that together make up the Sierra Nevada batholith were intruded. In the GRA the plutons apparently dissolved or forced aside the pre-existing rocks, leaving no or few roof pendants or septa that would make promising hosts for tungsten deposits. It is possible, however, that there are very late intrusives of this stage that may have produced porphyry copper resources, as was the case in the Yerington district 30 miles to the northeast.

After a long period of erosion that exposed the deeper parts of the Sierra Nevada batholith within the GRA and westward but left roof pendants and septa of pre-batholithic rocks to the east, volcanism during the Miocene covered all the older rocks with a thick sequence of principally andesitic mudflows and pyroclastics. Later volcanism during the Pliocene added to the cover with andesite, rhyolite and dacite flows and associated pyroclastics. Besides the extrusive rocks, this volcanism produced late-stage hydrothermal solutions that deposited precious metal ore bodies at a number of places in the GRA and the surrounding region.

Late in the period of volcanism, north-south faulting with substantial displacement began, tilting the Tertiary strata and the underlying older rocks to the west in many of the resulting structural blocks, including the one in which the WSAs lie. Faults of other attitudes also were developed, though their age relationship to the north-south faults is unknown.

Soon after faulting started, erosion of the uplifted or uptilted portions of the blocks also started, and continues to the present. One result of this erosion was the complete removal of the Tertiary rocks in part of WSA CA 010-105, exposing the underlying granitic rocks of the Sierra Nevada batholith along the east side of the WSA.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

In the northwest part of the GRA are the two most productive districts of the area, both in Alpine County: Silver Mountain, about 10 miles west of the WSAs, and partly outside of the GRA, and Monitor-Mogul, about five miles northwest of the WSAs. Total gold-silver production from Alpine County is estimated at $3 million to $5 million, with most of it coming from the Monitor-Mogul district and an estimated $300,000 from Silver Mountain (Clark, 1977). Three miles south of the WSA, beyond the GRA boundary, is the Silver King district which Clark (1977) shows on his map and describes as only two gold-silver properties that have produced little or no metal.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

About five miles southeast of the WSAs, in Mono County and outside the GRA are the Al Mono and Golden Gate properties, both gold-bearing quartz veins which apparently have produced little or no ore (Sampson, 1940). The general area in which they lie is as an area of extensive alteration that has promising aspects for modern prospecting (Blakestad, R., District Geologist, Homestake Mining Co., oral communication, 1982).

About three miles south of the WSA, in Alpine County, is the Snodgrass Creek prospect, described by Clark (1977) as an iron-stained quartz vein containing small amounts of pyrite, galena and scheelite. The latter is a tungsten mineral.

3. Mining Claims

There are a few patented claims in the northwestern part of the GRA, all in the vicinity of either the Monitor-Mogul district or the Silver Mountain district.

There are a great many unpatented claims in the western part of the GRA -- it appears that nearly the entire western half has been entirely covered with them. The pattern suggests that this is systematic staking performed by major mining companies, probably covering extensive altered areas.

The eastern half of the GRA, in which the WSAs lie, has no patented claims and very few unpatented claims. However, there are claims in the eastern halves of Secs. 12 and 13,

T 9 N, R 31 E, which straddle the Alpine-Mono County border and the boundary between WSA CA 010-105 and WSA NV 030-531. These claims must lie in one or the other WSA, possibly in both.

4. Mineral Deposit Types

The gold-silver ores and occurrences of the GRA are epithermal veins deposited by hydrothermal solutions related to the still-buried magma bodies that were the sources of the widespread volcanic rocks of the area. Clark (1977) describes very extensive zones of alteration in the Monitor-Mogul and Silver Mountain districts, where the rocks have been bleached and in part silicified. From his description, it seems likely that altered areas do indeed underlie the very large area that has been covered with unpatented mining claims.

In the Monitor-Mogul district the ores apparently occur as ill-defined small pockets or volumes of disseminated mineralization, the gold and silver associated with complex mixtures of base metal sulfides. Apparently there are discernable veins or other structures that the miners could follow, but not quartz veins such as one might expect. Clark's (1977) description of the Silver Mountain district, however, specifies that the gold and silver occur in quartz veins or silicified zones, apparently with much smaller quantities of base metals than are found at Monitor-Mogul.

The prospects south of the WSAs apparently are similar to those described above, but perhaps with less extensive altered areas.

The Snodgrass Creek tungsten occurrence, described as a quartz vein with small amounts of pyrite, galena and scheelite by Clark (1977), is not at all like the most common tungsten occurrences and deposits of the region -- contact metamorphic bodies in tactite. Quartz vein occurrences of scheelite are known, however, and Clark (1977) implies that there are others in Alpine County. Few of them in the region have had sufficient size or tungsten grade to be mineable, however. Perhaps the Silver Dyke mine (Kerr, 1936), 80 miles south-southeast of the GRA, is the only one that has been mined extensively.

5. Mineral Economics

The mining that has been done in the GRA has all been underground, and small-scale by modern standards. Although the sum total of underground work implied by Clark (1977) is large, the amount of precious metals produced was small and the ore bodies as described were

small as well. Similar small-scale mining might be undertaken by individuals or small companies in the future, but in most cases it is likely that start-up and production costs will be greater than the value of metals produced.

The extensive, big company-scale staking in the western part of the GRA suggests that one or more large mining organizations consider the area to have potential for a large orebody, perhaps mineable by open pit methods.

The major use of gold is for storing wealth. It is no longer used for coinage because of monetary problems, but many gold "coins" are struck each year for sale simply as known quantities of gold that the buyer can keep or dispose of relatively easily. The greatest other use of gold is in jewelry, another form of stored wealth. In recent years industrial applications have become increasingly important, especially as a conductor in electronic instrumentation. In the United States and some other countries gold is measured in troy ounces that weigh 31.1 grams -- twelve of which make one troy pound. Annual world production is about 40 million ounces per year, of which the United States produces somewhat more than one million ounces, less than one-fourth of its consumption, while the Republic of South Africa is by far the largest producer at more than 20 million ounces per year. World production is expected to increase through the 1980s. For many years the price was fixed by the United States at $35 per ounce, but after deregulation the price rose to a high of more than $800 per ounce and then dropped to the neighborhood of $400 per ounce. At the end of 1982 the price was $460.50 per ounce.

The major uses of silver are in photographic film, sterlingware, and increasingly in electrical contacts and conductors. It is also widely used for storage of wealth in the form of jewelry, "coins" or bullion. Like gold it is commonly measured in troy ounces, which weigh 31.1 grand grams, twelve of which make one troy pound. World production is about 350 million ounces per year, of which the United States produces about one-tenth, while it uses more than one-third of world production. About two-thirds of all silver is produced as a byproduct in the mining of other metals, so the supply cannot readily adjust to demand. It is a strategic metal. Demand is expected to increase in the next decades because of growing industrial use. At the end of 1982 the price of silver was $11.70 per ounce.

More than half of all tungsten used is in the form of tungsten carbide, a hard and durable material used in cutting tools, wear-resistant surfaces and hard-faced welding rods. Lesser quantities are used in alloy steels, in light bulb filaments, and in chemicals. World

production of tungsten is nearly 100 million pounds annually, of which the United States produces somewhat more than six million pounds, while using more than 23 million pounds. The shortfall is imported from Canada, Bolivia, Thailand and Mainland China, as well as other countries. Tungsten is a strategic and critical metal. United States demand is projected to about double by the year 2000, and most of the additional supply will probably be imported, because large reserves are in countries in which profitability is not a factor -- they need foreign exchange, and therefore sell at a price that few domestic mines can match. Tungsten prices F.O.B. mine are quoted for "short ton units", which are the equivalent of 20 pounds of contained tungsten. At the end of 1982 the price of tungsten was about $80 per short ton unit.

The largest use for copper is in electrical equipment and supplies and in smaller-guage wire where its electrical conductivity is essential. It is also used in large quantities in applications where its corrosion resistance is important -- in housing, brass and bronze, sea-water corrosion resistant alloys and others. It is used also in ammunition, many chemicals, and in applications where its conductivity of heat is important. World production is about 7.5 million metric tons annually, of which the United States produces about 1.5 million tons, nearly sufficient to satisfy domestic demand. Copper is a strategic metal. There are large reserves of copper ore in the world, and the United States has greater reserves and greater resources than any other country. United States demand is expected to nearly double by the year 2000, but reserves are thought to be sufficient to meet the demand. However, environmental problems of smelting copper may hinder production, and in times of low prices foreign producers tend to maintain full production for political reasons, while domestic producers tend to restrict production for economic reasons. These pressures on the domestic copper industry weaken its competitive capability on the world market. At the end of 1982 the price of copper was 73 cents per pound.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

About five miles northwest of the north end of the WSAs is the Leviathan mine, which between 1951 and 1962 produced 465,616 tons of sulfur valued at $14.5 million. This production was made by the Anaconda Company, which used the sulfur in processing copper ore at its Weed Heights mine near Yerington, Nevada, 30 miles northeast. When the Anaconda Company no longer needed sulfur the mine was shut down and has not been worked since for lack of a nearby sulfur market (Clark, 1977).

Several limestone quarries have been operated five miles to fifteen miles west of the GRA (Clark, 1977) but none are currently operating. Again, the lack of a nearby market was the main factor in their closing down.

Sand and gravel have been quarried at various points in the region, but no pits have been identified in the GRA and none in the WSA.

Crushed rock has been quarried from the relatively large Wolf Creek pit in the southwest part of the GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There are no known prospects, occurrences or areas mineralized with nonmetallic minerals in the GRA, and more particularly, none are known in the WSAs.

3. Mining Claims, Leases and Material Sites

Although there are a great many unpatented mining claims, none have been identified as having been located for nonmetallic minerals. There are no leases for nonmetallic minerals in the GRA. No material sites are known in the WSAs.

4. Mineral Deposit Types

The Levithan mine extracted sulfur from an elliptical lens of ore 90 feet thick and 2,400 feet long in Tertiary volcanic rocks. The sulfur impregnates the lower part of a tuff bed and part of the underlying andesite(?), in part apparently replacing some of the rock, but also in part filling pore spaces in the tuff as well as fractures. In places the host rocks have been bleached and/or silicified (Clark, 1977). It seems clear that this deposit is an unusual result of the hydrothermal solutions that produced the extensive alteration in and near the GRA, as well as the epithermal gold-silver mineralization.

The limestone quarries west of the GRA mined crystalline limestone from roof pendants of metasediments lying in the Sierra Nevada batholith.

Sand and gravel operations have been well to the north and west of the GRA in large river valleys. Alluvial gravel deposits were mined.

The Wolf Creek rock quarry within the GRA mined a fresh, unaltered andesite.

5. Mineral Economics

Sulfur is the only relatively high-priced nonmetallic mineral known in the GRA. Despite its relatively high price, its most commonly-used derivative, sulfuric acid, is a product of many industrial pollution-control installations. The readily available of acid from these sources makes it unlikely that the Leviathan mine can be successfully reopened in the forseeable future. There is no known favorability for sulfur resources in the WSAs.

Limestone, sand and gravel, and crushed stone in this region have markets mostly in heavy construction, principally highway construction. Probably one or two of the quarries in the region are nearly continuously operated, while others open in response to local demand, and close when the particular project is finished.

Pure limestone and dolomite are used principally to produce lime, but some is used as rock for building stone, crushed rock, and similar applications. The principal uses of lime are in steel smelting, water purification, as an alkali, in paper and pulp manufacture, and sewage treatment. Other uses for lime are in sugar purification, mortar, and as an agricultural soil conditioner. Limestone with certain clay impurities (called cement rock), or purer limestone with clay added, is used to make cement that is mostly consumed in construction. The United States uses about 20 million tons of lime and 85 million tons of cement annually. For both lime and cement the raw material must be mined within a very few miles of the processing plant, because it has a very low value in the form of run-of-mine rock -- two or three dollars per ton. There are numerous lime and cement plants in the United States, and most of them sell most of their product within a 200 mile radius of the plant. Some cement is imported in the form of clinker, which is the kiln-fired rock that is then ground in the United States. In the early 1980s the price FOB plant of both lime and cement is about $40 per ton.

The most common use of sand and gravel is as "aggregate" -- as part of a mixture with cement to form concrete. The second largest use is as road base, or fill. About 97 per cent of all sand and gravel used in the United States is in these applications in the construction industry. The remaining three percent is used for glassmaking, foundry sands, abrasives, filters and similar applications. The United States uses nearly one billion tons of sand and gravel annually, all of it produced domestically except for a very small tonnage of sand that is imported for highly specialized uses. Since construction is by far the greatest user of sand and gravel, the largest production is near sites of intensive construction, usually metropolitan areas. Since sand and gravel are extremely

common nearly everywhere, the price is generally very low and mines are very close to the point of consumption -- within a few miles as a rule. However, for some applications such as high-quality concrete there are quite high specifications for sand and gravel, and acceptable material must be hauled twenty miles and more. Demand for sand and gravel fluctuates with activity in the construction industry, and is relatively low during the recession of the early 1980s. Demand is expected to increase by about one third by the year 2000. In the early 1980s the price of sand and gravel F.O.B. plant averaged about $2.50 per ton but varied widely depending upon quality and to some extent upon location.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There has been no uranium or thorium production and there are no known uranium or thorium deposits within the GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There are no uranium or thorium occurrences within the WSA or the GRA though there are several uranium prospects west of the GRA. These are indicated on the Uranium Land Classification and Mineral Occurrence Map. The Geranium Claims, Sec. 32(?) T 9 N, R 20 E have uranium, molybdenum, lead, and zinc concentrations in a carbonaceous sandstone. The deposit is in a paleo-stream channel of the lower fluviatile member of the Tertiary(?) Relief Peak Formation, which had incised into the underlying granitic rocks. The Bolin claims, Sec. 16, T 9 N, R 20 E show radioactivity in the granite. The Shirley and Mary E claims, Sec. 33, T 9 N, R 19 E have autunite in a clayey matrix associated with granite (Minobras, 1978).

3. Mining Claims

There are no known uranium or thorium claims or leases within the GRA.

4. Mineral Deposit Types

There are no known uranium or thorium deposits within the GRA so deposit types cannot be discussed..

5. Mineral Economics

The lack of known uranium and thorium deposits and exploration within the GRA prevents an economic determination for the area.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States

ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1970s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Thorium is used in the manufacture of incandescent gas mantles, welding rods, refractories, as fuel for nuclear power reactors and as an alloying agent. The principal source of thorium is monazite which is recovered as a byproduct of titanium, zirconium and rare earth recovery from beach sands. Although monazite is produced from Florida beach sands, thorium products are not produced from monazite in the United States. Consequently, thorium products used in the United States come from imports, primarily from France and Canada, and industry and government stocks. Estimated United States consumption of thorium in 1980 was 33 tons, most of which was used in incandescent lamp mantles and refractories (Kirk, 1980b). Use of throium as nuclear fuel is relatively small at present, because only two commercial thorium-fueled reactors are in operation. Annual United States demand for thorium is projected at 155 tons by 2000 (Kirk, 1980a). Most of this growth is forecast to occur in nuclear power reactor usage, assuming that six to ten thorium-fueled reacotrs are on line by that time. The United States and the rest of the world are in a favorable position with regard to adequacy of thorium reserves. The United States has reserves estimated at 218,000 tons of ThO_2 in stream and beach placers, veins and carbonatite deposits (Kirk, 1982); and probable cumulative demand in the United States as of 2000 is estimated at only 1800 tons (Kirk, 1980b). The price of thorium oxide at the end of 1981 was $16.45 per pound.

Oil and Gas Resources

There are no known oil and gas deposits, hydrocarbon shows in wells, or surface seeps in the region; nor are there any Federal oil and gas leases in the immediate region. The goelogical environment of the WSAs -- all igneous rocks -- is unfavorable for the accumulation of oil or gas

resources. There is no oil and gas lease map, nor an oil and gas occurrences and land classification map in this report.

Geothermal Resources.

1. Known Geothermal Deposits

   There are no known geothermal deposits present.

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas.

   There are three unnamed wells and springs noted to be warm (<50°C) which are in Antelope Valley immediately to the east of the GRA (see Geothermal Mineral Occurrence and Land Classification Map). These thermal occurrences appear to be controlled by the Cenozoic high-angle faulting, especially evident on the east side of the valley (NOAA, 1980).

3. Geothermal Leases

   There are no Federal leases or lease applications in the area. There is no Geothermal Lease Map included in the report.

4. Geothermal Deposit Types

   The three Antelope Valley occurrences are surface and near-surface thermal waters that rise along the Basin and Range faults, and appear at the surface as springs or enter an aquifer where they are accidently intersected by a water well. Any one of these thermal water sources might be utilized for space heating or other direct uses.

5. Geothermal Economics

   An estimated measure of the known sites of geothermal resources has been published in Circular 790 (Muffler, 1979) by the U.S. Geological Survey:

(1) Grovers Hot Springs

(2) Fales Hot Springs

(1)	(2)	Characteristics
110°-137°C	84°-145°C	Estimates of reservoir temperature
126° ± 6°C	116° ± 12°C	Mean reservoir temperature
3.3 ± 0.9	3.3 ± 0.9	Mean reservoir volume (Km^3)
1.00±0.28	0.91±0.28	Mean reservoir thermal energy (10^{18}J)
0.25	0.23	Willhead thermal energy (10^{18} J)
0.060	0.055	Beneficial heat (10^{18}J)

The boundaries of the resource and the values indicated will undoubtedly change with additional drilling and other exploratory surveys.

Geothermal resources are utilized in the form of hot water or steam noramlly captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year around mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystallization (266°F), and drying of diatomaceous earth (338°F).

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a reource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

No other geological resources are known in the Slinkard GRA.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981-March 1982, states that the term "strategic and ctitical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.

There is very little favorability for tungsten, a critical metal, in WSA CA 010-105 or WSA NV 030-531, despite the occurrence of deposits elsewhere in the region.

It is possible that there may be resources of copper, a strategic metal, in the WSA.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES POTENTIAL

Curtis's work (1951) provides good mapping of rock types and distribution in WSAs CA 010-105 and NV 030-531, and our level of confidence in this aspect of the geology is high. However, Curtis was little concerned with alteration and mineralization, and we found no other work specifically covering the WSAs that was concerned with these aspects of geology. The quantity and quality of information about alteration and mineralization are low. The presence of claims in four quarter sections along the boundary between the two WSAs suggests that there is alteration or some other feature that has attracted prospecting activity. Therefore, our level of confidence in geological data pertaining directly to mineral potentail is very low.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g. M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSAs. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability with low confidence, for nometallic mineral potential, since any mineral material can at least be used in construction application.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA CA 010-105

M1-1C. This classification area covers the northeastern part of WSA CA 010-105, that part in which granitic rocks are mapped. Granitic rocks with no particular structural, mineralization or alteration features known that might indicate otherwise, in general have low favorability for metallic minerals. Confidence in this classification is moderately high because there is nothing in the literature to suggest otherwise, and the lack of claims indicates that favorable features are present to attract the attention of prospectors.

M2-2A. This classification area includes the westernmost part of WSA CA 010-105, making a narrow strip along its edge. The presence of unpatented claims in a two mile long strip along this edge of the WSA suggests that there is some alteration or other indication of mineralization. The possible north-south fault in ferred to local Tertiary intrusions north and south of the WSA, discussed in II3 above, could be the localizing geologic feature for this. The confidence level for this classification is necessarily low.

M3-2A. This classification area covers all of the WSA except that part covered by M1-1C; it includes the area of M2-2A. It represents the potential for porphyry copper resources related to Sierra Nevada age intrusions (such as those in the Yerington district 30 miles northeast) in the pre-Tertiary rocks that lie under the Tertiary volcanics. Its confidence level is low, since there is only the regional existence of such resources to support it.

WSA NV 030-531

M2-2A. This classification area covers about half of the northern tip of the WSA. The rationale for the classification and the level of confidence is given above under WSA CA 010-105.

M3-2A. This classification area covers all of the WSA including the area of M2-2A. The rationale for the classification and the level of confidence is given above under WSA CA 010-105.

b. Uranium and Thorium

WSAs CA 010-105 and NV 030-531

U1-3B. This land classification area covers essentially all of the GRA and both WSAs. Late Tertiary to early Quaternary andesite and rhyolite flows cover most of the GRA including the western and southern portions of the WSAs. The eastern section of the WSAs is comprised of late Jurassic granitic rocks which include alaskites and pegmatites. The rhyolitic volcanics and granitic rocks of the WSAs are favorable source rocks for uranium and local concentration of uranium may occur in veins and fractures of these units. Uranium and thorium could occur in economic concentrations in the alaskites and pegmatites as primary minerals.

The WSAs are moderately favorable for uranium concentration at a moderate confidence level, especially if the lower fluviatile member of the Miocene Relief Peak Formation, a good uranium host rock, is present within the GRA. The Relief Peak Formation underlies much of Alpine County and the lower fluviatile member rarely crops out as it is covered by resistant volcanics. California's largest uranium producer, the Juniper mine, produced 45,500 pounds of uranium from its deposit in sandstone of the lower Relief Peak Formation.

The fluviatile member of the Relief Peak Formation is ideal for uranium concentration as it is permeable, contains abundant carbonaeous material to reduce uranium and precipitate it from ground water, and it is underlain and overlain by less permeable granitic and volcanic rocks.

There are three uranium occurrences west of the WSAs and the GRA. Two of these occurrences are in granitic rocks, and the third has uranium associated with molybdenum, lead, and zinc in the lower fluviatile member of the Relief Peak Formation. There are no reported occurrences of thorium within or near the WSA or the GRA.

The area has low favorability at a low confidence level for thorium deposits in pegmatites.

c. Nonmetallic Minerals

WSAs CA 010-105 and NV 030-531

M1-2B. This classification area includes all of WSAs CA 010-105 and NV 030-531. There are no known nonmetallic mineral resources in the WSA, but a use can be found for almost any mineral material so it is possible that some

use may be made of the granitic or volcanic rocks in the WSA.

2. LEASABLE RESOURCES

a. Oil and Gas

WSAs CA 010-105 and NV 030-531

OG1-1D. There has been no serious oil and gas exploration, nor are there any recorded occurrences of oil and gas in this westernmost sector of the Basin and Range province where it meets the Sierra Nevadas. The WSAs are underlain by the Sierra Nevada batholith and a thick section of Pliocene volcanics, both of which are highly unfavorable as source rocks for oil or gas. There is no oil and gas map, nor is there an oil and gas occurrences and land classification map in this report.

b. Geothermal

WSAs CA 010-105 and NV 030-531

G1-3B. The bulk of the GRA, including both WSAs and the region to the west and north, is largely underlain by young volcanics. Pliocene volcanics including rhyolites and Pleistocene volcanics persist within the GRA/WSA or are close by. These relatively young silicic volcanics suggest a very favorable heat source at depth. Strong, regional normal faulting, similar to the Antelope Valley faults, cuts through the entire GRA and on beyond to the northwest. There, seven to ten miles outside the GRA, is a commercial resort, Grovers Hot Springs (64°C at 400 l/min. and a salinity of 1720 mg/l), and an unnamed spring (65°C at 475 l/min) (NOAA, 1980). These hot springs are each located on faults. A similarly trending major high-angle fault passes through the WSAs and another crosses them in a southeasterly direction. There is no geothermal lease map in this report, but a Geothermal Occurrences and Land Classification Map is included at the back of the report.

c. Sodium and Potassium

S1-1D. This classification applies to the entire WSA. The geological environment has nofavorability for the accumulation of resources of sodium and potassium.

3. SALEABLE RESOURCES

Saleable resources have been covered under Nonmetallic Minerals, above.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

At least the eastern halves of Sections 12 and 13, T 9 N, R 31 E should be examined in the field to determine why there are mining claims in this area, within one or both of WSAs CA 010-105 and NV 030-531. Probably these claims are located on an area of alteration, and if so the extent of this alteration should be mapped and the area geochemically sampled.

VI. REFERENCES AND SELECTED BIBLIOGRAPHY

Albers, J. P., Roberts, R. J., Silberling, N. J., and Stewart, J. H., 1964, Generalized stratigraphic correlation chart for Nevada, in Mineral and water resources of Nevada: Nevada Bur. Mines Bull. 65 (U.S. 88th Cong., 2nd sess. Senate Document 87), p. 14-15.

American Bureau of Metal Statistics Inc., 1982, Non-ferrous metal data -- 1981, Port City Press, New York, New York, p. 133-134.

Banner, G. C., 1959, Sulfur in California and Nevada: U. S. Bur. Mines Inf. Circ. 7898, 50 p.

Bateman, P. C., and Merriam, C. W., 1954, Geologic map of Owens Valley region, California: California Map Sheet 11, R. H. Jahns editor.

-----,1961, Willard D. Johnson and the strike-slip component of fault movement in the Owens Valley earthquake 1872: Bull. Seismol. Soc. America, v. 51, no. 4, p. 485-493.

Bateman, P. C., and Wahrhaftig, C., 1966, Geology of the Sierra Nevada, in Bailey, E. H. (ed.) Geology of northern California: California Div. Mines and Geology Bull. 190, p. 107-172.

Clark, W. B., 1970, Gold districts of California: Calif. Div. Mines and Geology Bull. 193, 186 p.

Clark, W. B., 1977, Mines and mineral resources of Alpine County, California: California Div. Mines and Geology, County Report 8. Geologic map, very difficult to use. Text almost entirely descriptions of districts and mines.

Crawford, J. J., 1894, Silver-Alpine County: Cal. Min. Bur. Rept. 12.

Curtis, G. H., 1951, The geology of Topaz Lake quadrangle and the eastern half of the Ebbetts Pass quadrangle: Univ. California Berkeley unpublished PhD thesis. Good rock descriptions, geologic map; little pertaining to mineral deposits.

Evernden, J. F., Savage, D. E., Curtis, G. H., and James, G. T., 1964, Potassium argon dates and the Cenozoic mamalian chronology of North America: American Jour. Sci., v. 262, p. 145-198.

Firby, J. R., 1969, Late Cenozoic Non-Marine Mollusca of Western Nevada and Adjacent Areas: Univ. California, Berkeley, Ph.D., dissertation,

Franks, A. L., 1970, Geological report on source of mineral water from Levithan mud, Alpine Co., California: Water Resources Control Board office report p. 9.

Garside, L. J. and Schilling, J. H., 1979, Thermal waters of Nevada: Nevada Bureau of Mines and Geology, Bull. 91.

Hanna, G. D., 1963, Some Pleistocene and Pliocene freshwater mollusca from California and Oregon: California Acad. Science. Occasional Paper 43, p. 14-17.

Jenkins, O. P., 1950, Copper in California: Calif. Div. Mines and Geology Bull. 144.

Kerr, P. F., 1936, The tungsten mineralization in Silver Dyke, Nevada: Nev. Bur. Mines Bull 28.

Kirk, William S., 1980a, Thorium in Mineral Facts and Problems, 1980 ed., U. S. Bureau of Mines, Bull. 671, p. 937-945.

Kirk, William S., 1980b, Thorium in Minerals Yearbook, vol. I, Metals and Minerals, U. S. Bureau of Mines, p. 821-826.

Kirk, William S., 1982, Thorium in Mineral Commodity Summaries - 1982, U. S. Bureau of Mines, p. 160-161.

Koenig, J.B., 1963, Walker Lake Sheet, Geologic Map of California: Calif. Div. Mines and Geology.

Koenig, J. B., 1963, Gelogic map of Califonia, Walker Lake sheet: California Div. of Mines and Geology.

Luedke, R. G. and Smith, R. L., 1981, Map showing distribution, composition, and age of Late Cenozoic volcanic centers in California and Nevada: U. S. Geol. Survey Map I-1191-C. Generalized distribution of volcanic rocks of less than 16 my. age only. Shows locations of volcanic vents in this GRA, and a few age dates.

McKee, E. H., Silberman, M. L., Marvin, R. E., and Obradovich, J. D., 1971, A summary of radiometric ages of Tertiary volcanic rocks in Nevada and eastern California; part 1, central Nevada: Isochron West, no. 2.

Mining Journal, July 24, 1981, Vol. 297, No. 7641.

Minobras, 1978, Uranium deposits of California, Arizona and Nevada.

Muffler, L. J. P., ed., 1979, Assessment of geothermal resources of the United States - 1978: U. S. Geol. Survey Circ. 790.

Moore, J. G., 1969, Geology and mineral deposits of Lyon, Douglas, and Ormsby Counties, Nevada: Nev. Bur. Mines and Geol., Bull. 75. Better geology than available for Alpine or Mono Counties, partly projectable into the GRA.

NOAA/National Oceanic and Atmospheric Administration, 1980, Geothermal resources of California: Map prep. by Nat. Geophy. and Solar-Terrestrial Data Center from data compiled by California Division of Mines and Geology, California Geologic Data Map Series, Map No. 4.

Norman, L.A., Jr., 1951, Alpine County, California: Jour. Min. and Geol. v. 47, p. 30.

-----1949, Alpine County, Calif. Div. Mine, Bull. 142, p. 32-33.

Reed, R. D., 1933, Geology of California: American Assoc. Petrol. Geologists, 24:1-355.

Russel, I. C., 1889, Quaternary history of Mono Valley, California: U. S. Geol. Survey Ann. Rept. 8, p. 261-394.

Sampson, R. J., 1940, Mineral resources of Mono County, California: California Div. Mines, California Jour. Mines and Geology, v. 36, no. 2. Brief descriptions of mines and prospects, mostly concerned with mining rather than geology.

Scholl, D. W., vonHuene, R., St.-Amand, P., and Ridlon, J. B., 1967, Age and origin of topography beneath Mono Lake, a remnant Pleistocene lake, California: Geol. Soc. America Bull., v. 78, p. 583-600.

Silberman, M. L., and McKee, E. H., 1972, A summary of radiometric age determinations on Tertiary volcanic rocks from Nevada and eastern California; part 2, western Nevada: Isochron West, no. 4 .

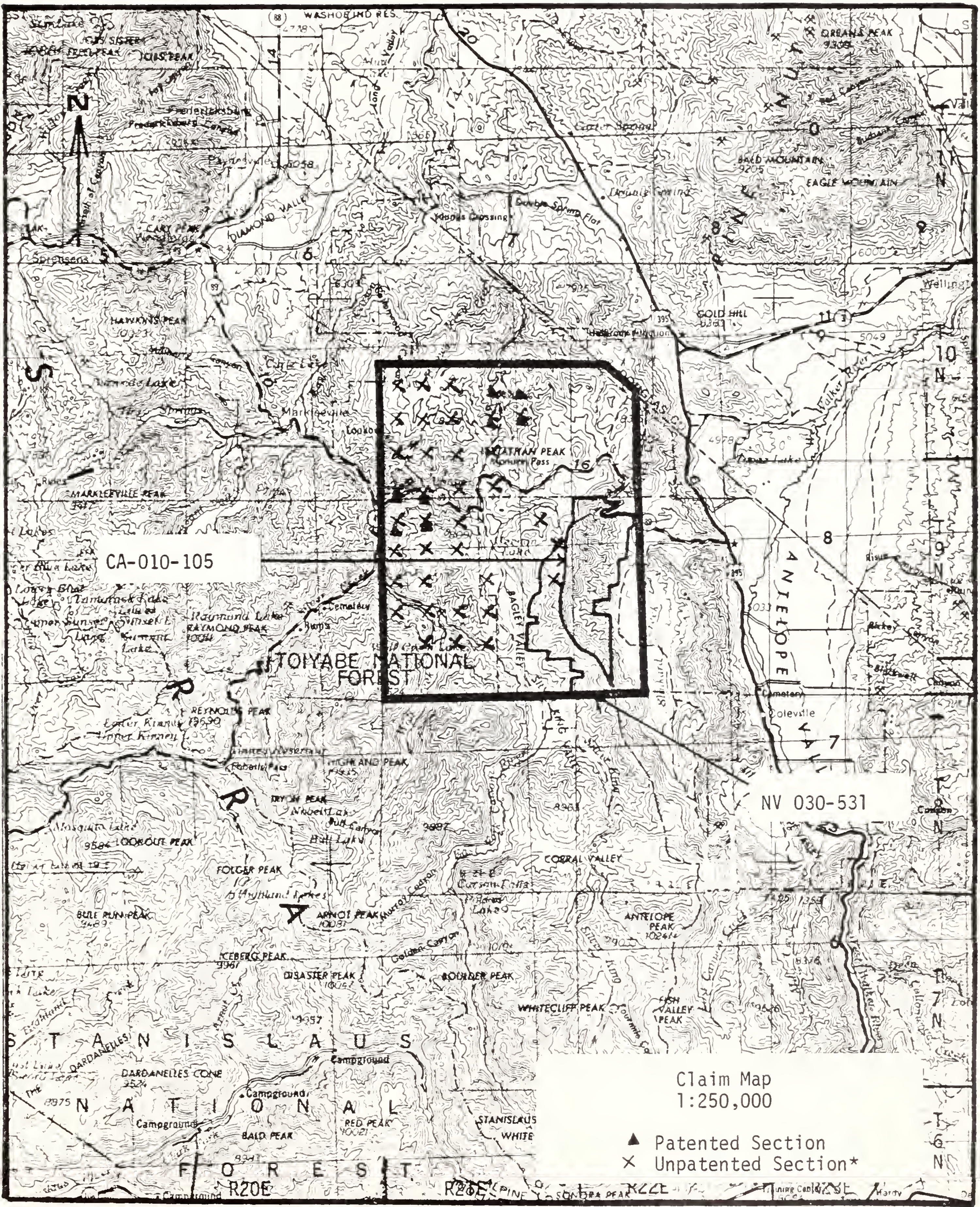
Taylor, D. W., 1975, Index and bibliography of late Cenozoic freshwater mollusca of western North America: Univ. Michigan Papers on Paleontology, no. 10.

Trexler, D. T., Koenig, B. A., and Flynn, T., compil., 1980, Geothermal resources of Nevada and their potential for direct utilization: Nevada Bur. of Mines and Geol., Map prepared for the U. S. Dept. of Energy under contract ET-78-S-08-1556.

U.S. Bureau of Mines, 1965, Mercury potential of the United States: U.S. Bur. Mines Inf. Circ. 8252, 376 p.

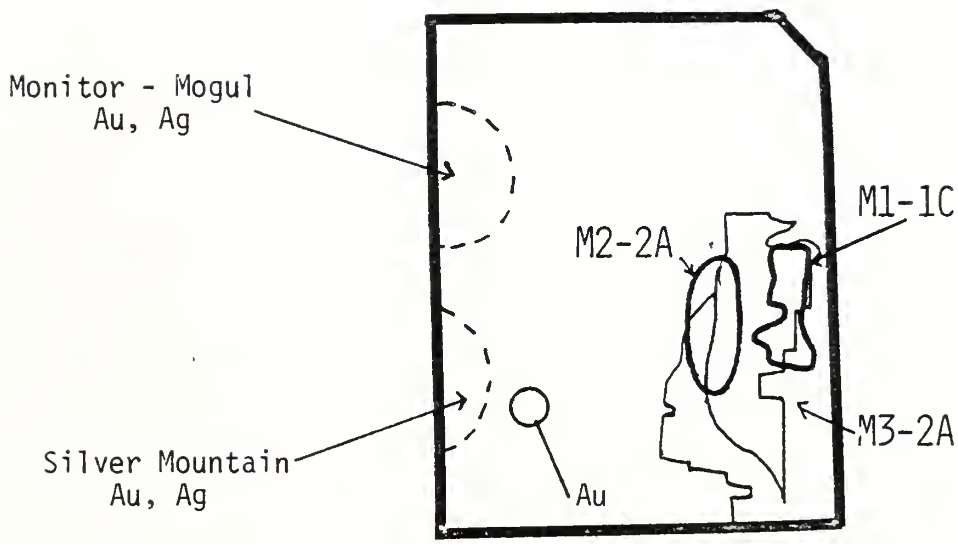
U.S. Geological Survey (and others), 1966, Mineral and water resources of California, Part 1, mineral resources: U.S. Cong. 89th, 2nd sess., U.S. Senate Comm. Interior and Insular Affairs, Comm. Print (Calif. Div. Mines and Geology Bull. 191), 450 p.

Wright, L. A., 1957, Mineral commodities of California: Calif. Div. Mines and Geology Bull. 176, 736 p.



*X denotes one or more claims per section

Slinkard GRA CA-01



EXPLANATION

Mining District, commodity

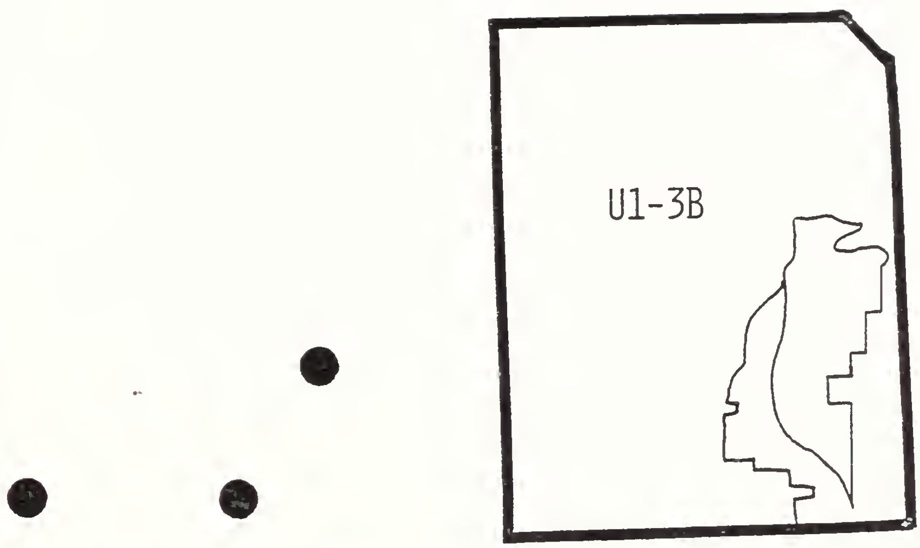
Occurrence, commodity

Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Metallics

Slinkard GRA CA-01
Scale 1:250,000



EXPLANATION

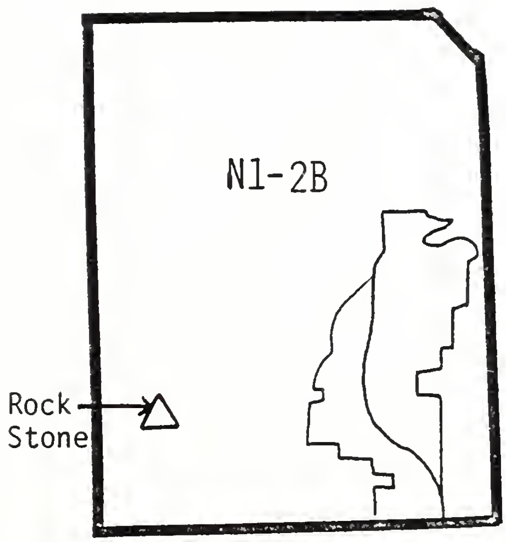
Uranium Occurrence

Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Uranium

Slinkard GRA CA-01
Scale 1:250,000



EXPLANATION

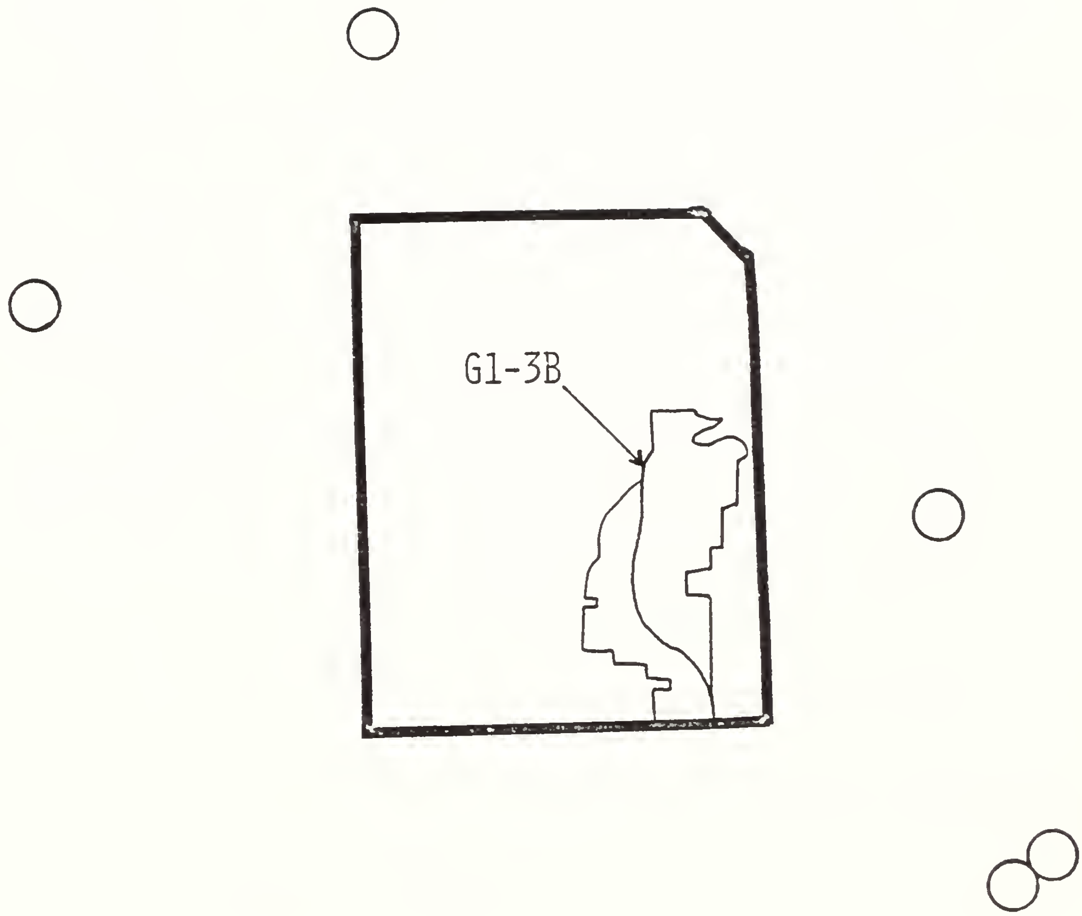
△ Mine, commodity

▬ Land Classification Boundary

— WSA Boundary

Land Classification - Mineral Occurrence Map/Nonmetallics

Slinkard GRA CA-01
Scale 1:250,000



EXPLANATION

◯ Thermal well

▬ Land Classification Boundary

— WSA Boundary

Land Classification - Mineral Occurrence Map/Geothermal

Slinkard GRA CA-01
Scale 1:250,000

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era	System or Period		Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic	Quaternary		Holocene	
			Pleistocene	2-3 [1]
	Tertiary		Pliocene	12 [1]
			Miocene	26 [2]
			Oligocene	37-38
			Eocene	53-54
			Paleocene	65
Mesozoic	Cretaceous [4]		Upper (Late) Lower (Early)	136
	Jurassic		Upper (Late) Middle (Middle) Lower (Early)	190-195
	Triassic		Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic	Permian [4]		Upper (Late) Lower (Early)	280
	Carboniferous Systems	Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
		Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian		Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]		Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]		Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]		Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [3]			Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

[1] Holmes, Arthur, 1965, Principles of physical geology: 2d ed., New York, Ronald Press, p. 360-361, for the Pleistocene and Pliocene, and Obradovich, J. D., 1965, Age of marine Pleistocene of California: Am. Assoc. Petroleum Geologists, v. 49, no. 7, p. 1087, for the Pleistocene of southern California.

[2] Geological Society of London, 1964, The Phanerozoic time-scale, a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970